



TECHNICAL REPORT

Improvements to the Dorado Trunk Sewer

CIP 2-26-5002

Program Management Services for
Implementation of the Capital
Improvement Program in the North
Region



Submitted:

September 2013

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Executive Summary

The Puerto Rico Aqueduct and Sewer Authority (PRASA) propose to improve the Dorado Trunk Sewer that reaches the Dorado Wastewater Treatment Plant (DWWTP). This trunk sewer is known to be overloaded and cause wastewater overflows. Additionally, the condition of the existing trunk sewer has prohibited or increased the cost of new developments' connection to the existing sewer system, by requiring pump stations with direct conveyance to the DWWTP.

In addition to present an alternative to alleviate the overloading in the existing Dorado trunk sewer, an analysis to determine if any of the communities in the study area can be connected to the DWWTP is presented. The analysis took into consideration if any of the existing pump station can be eliminated and change the connection from a force line to a gravity lateral sewer.

The planning effort has three objectives:

1. Alleviate the overloading of the existing Dorado trunk sewer.
2. Identify opportunities for elimination of existing sanitary pump stations by gravity lateral sewers to reduce operation and maintenance costs.
3. Proposed possible new connection infrastructure for communities without sanitary sewer system.

To address these objectives three implementation phases are proposed. Phase A is the recommended phase of the improvements that will address Objective 1. Phase B and C will address Objectives 2 and 3 respectively.

An opinion of probable cost is offered in this technical report. Table EX-1 summarizes the construction cost for the three phases.

Table EX-1: Opinion of Cost

Phase	Estimated Construction Cost	Total Investment
A	\$7,305,770	\$11,485,000
B	\$4,144,000	\$6,515,000
C	\$8,123,200	\$12,770,000

However, the recommendation is to initiate a design procurement stage for the design and eventual construction of Phase A.

1.1 Introduction

The Puerto Rico Aqueduct and Sewer Authority (PRASA) propose to improve the Dorado Trunk Sewer that reaches the Dorado Wastewater Treatment Plant (DWWTP). This trunk sewer is known to be overloaded and cause wastewater overflows. Additionally, the condition of the existing trunk sewer has prohibited or increased the cost of new developments' connection to the existing sewer system, by requiring pump stations with direct conveyance to the DWWTP.

The study has the objective of finding an alternative to eliminate the hydraulic overloading of one segment of the existing Dorado Trunk Sewer (Dorado TS). The section of the Dorado Trunk Sewer included in this evaluation is approximately 3 Km in length. It starts at the Quintas de Dorado Urbanization where the wastewaters coming from several urbanizations (Dorado Reef, Dorado Country Estates, Dorado Beach East, etc.) are combined for conveyance along the main street of the urbanization. Further downstream other developments are connected to the trunk sewer. Figure 1-1 shows the DWWTP service area. The wastewaters of the area to the west and south of the city are drained by the Dorado TS.

In addition to present an alternative to alleviate the overloading in the existing Dorado TS, an analysis to determine if any of the communities in the study area can be connected to the DWWTP is presented. The analysis considered if any of the existing pump stations can be eliminated and change the connection from a force line to a gravity lateral sewer.

1.2 Authorization

CH2M Hill / CH Caribe (CHC) is the Program Manager for the Puerto Rico Aqueduct and Sewer Authority's (PRASA) Capital Improvement Program (CIP) in the North and Metro Regions. Under subcontract with CHC, MP Engineers of Puerto Rico PSC (MPPR) is authorized to manage the pre-construction activities that pertain to PRASA's CIP in the North and Metro Regions. This project currently forms part of the Task Order 476-752 issued by CHC to MPPR.

1.3 Purpose

The purpose of this Technical Report (TR) is to present an alternative to alleviate the overloading of the existing Dorado trunk sewer and proposed lateral sewers to connect to the DWWTP communities that currently do not have sanitary sewer system. Based on this TR, a scope of work will be developed to request proposal(s) for the design of the first phase of the new Dorado TS.

1.4 Studies Area

The area evaluated comprises part of the Dorado, Toa Baja and Vega Alta municipalities and is shown in Figure 1-1. The wastewater flows generated in the study area drains to the DWWTP. The Dorado WWTP is a secondary treatment facility originally built in the 1960s. In 2006, the Dorado WWTP was upgraded from 2.02 MGD to 4.05 MGD design monthly average flow with peak flow capacity of 8.10 MGD. A separate project under the CIP number 2-26-5006 is addressing the necessary improvements to the DWWTP to attend operational problems in the facility.

The DWWTP receives the wastewater flow generated in seven communities, Dorado Pueblo, Dorado Club, Sabanera, Toa Baja Pueblo, Monte Helena and Los Prados (Figure 1-2). These communities have approximately 20,108 inhabitants. The annual average flow for the DWWTP was 2.29 MGD for the 2012, with a maximum flow of 3.80 MGD for the same period.

The plants main trunk sewer starts at the Quintas del Dorado urbanization and have segments of 30" and 36" diameter pipe until reaching the DWWTP. This trunk sewer is aligned going south, crossing the Quintas de Dorado Urbanization and continuing going south until reaching Route PR-696 where the pipeline turns east and continues along this road before going cross country until reaching route PR-693 where it turns north alongside PR-693 until reaching the DWWTP. Figure 1-2 presents the existing infrastructure connected to the DWWTP. The service area has 16 sanitary pump stations; nine of them are operated by private entities.

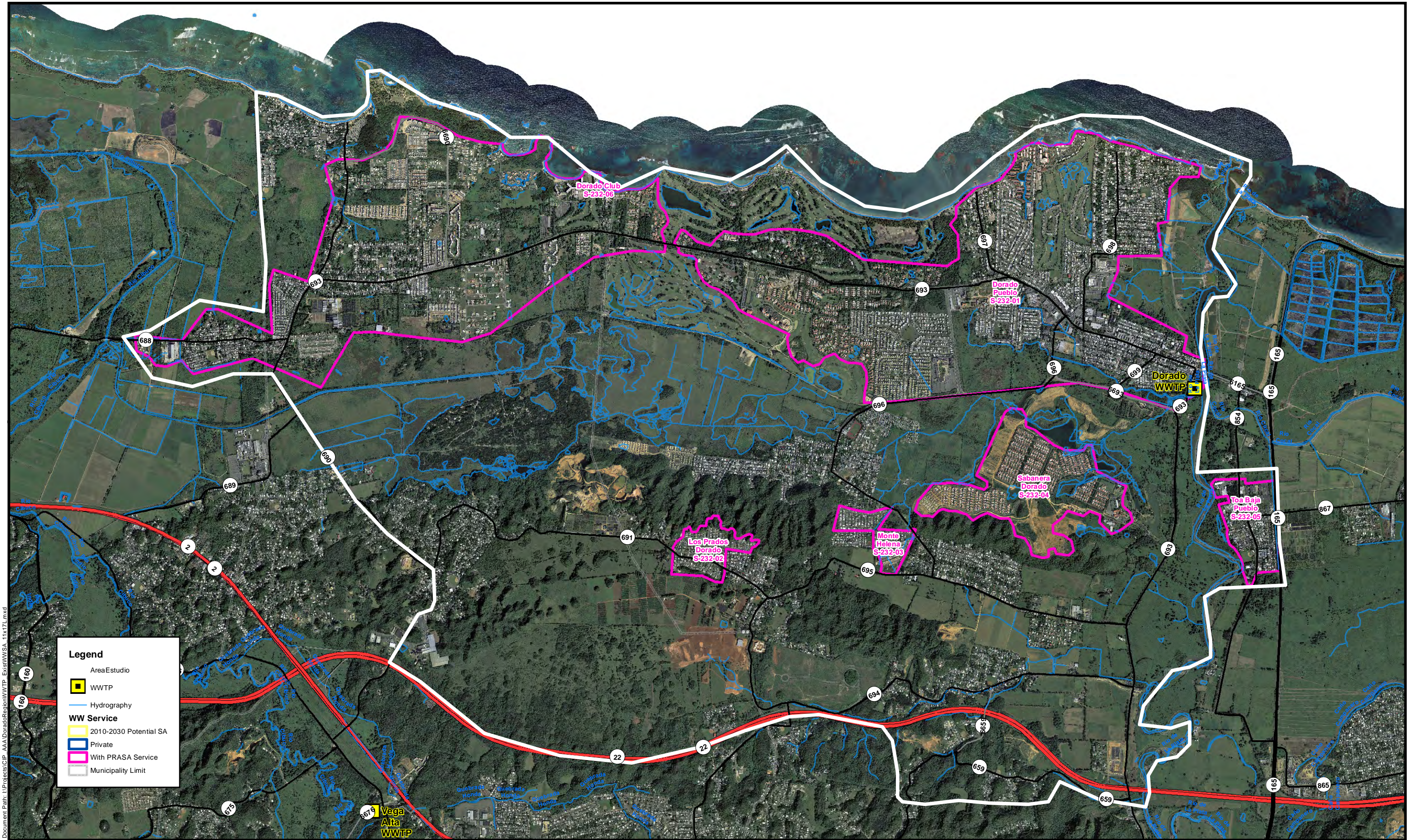


Figure 1-1 - Dorado WWTP Service Areas

Improvements to Dorado Trunk Sewer CIP 2-26-5002

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A population and flow projection analysis was performed to estimate the existing per capita flow contribution, to be able to estimate the future contribution of the communities that are currently connected and the remaining capacity that will be available at the DWWTP. The basis for the population and flow estimates are the 2010 United States Census and the Discharge Monitoring Reports of the DWWTP. The planning period comprises from 2012 to 2038.

2.1 Population Estimate

The population currently connected to the DWWTP consists of 20,108 inhabitants. This population is distributed in three municipalities, Dorado, Vega Alta and Toa Baja. It was assumed that the communities in the DWWTP service area will have the same population change behavior as their corresponding municipalities served. Therefore, a combined behavior was estimated for the Dorado, Vega Alta and Toa Baja municipalities. Table 2-1 presents the municipalities' population change for the period of 2010 to 2038 and the population change for the combined municipalities. The municipalities' population projection for year 2012, 2015, 2020 and 2025 are based on the Puerto Rico Planning Board projections. To obtain the population projection for years 2030, 2035 and 2038 a polynomial regression was used. As can be observed in the table the combined municipalities population projection for the 2038 is 174,048 inhabitants, which represents a combined increase of 3.6% when compared to the 2010 US census population.

Table 2-1: Population Estimates and Projections

	Year								Adjusting Factor ³
	2010	2012 ²	2015	2020	2025	2030 ⁴	2035 ⁴	2038 ⁴	
Dorado's Population ¹	36,563	36,920	37,456	38,116	38,502	38,614	38,452	38,223	104%
Adjusted Dorado's Population	38,165 ²	38,538	39,097	39,786	40,189	40,306	40,137	39,898	
Vega Alta's Population ¹	39,553	40,523	41,979	42,847	43,527	44,019	44,323	44,415	101%
Adjusted Vega Alta's Population	39,951 ²	40,931	42,401	43,278	43,965	44,462	44,769	44,862	
Toa Baja's Population ¹	98,939	99,569	100,515	101,488	102,927	94,946	97,094	98,585	91%
Adjusted Toa Baja's Population	89,609 ²	90,180	91,036	91,918	93,221	85,993	87,938	89,288	
Total Population	175,055	177,012	179,950	182,451	184,956	177,579	179,869	181,223	96%
Adjusted Total Population	167,725	169,649	172,535	174,982	177,375	170,761	172,843	174,048	

¹ Population based on the 2000 Puerto Rico Planning Board projections

² Population based on the 2010 United States Census

³ Adjusting factor based on the 2010 Adjusted population between the 2010 municipality population, and applied to year 2012 to 2038.

⁴ 2030 to 2038 population projections based on a polynomial regression method of the population change behaviour for the 2015, 2020 and 2025.

For this report, it was assumed that the communities of the DWWTP service area will follow the population change behavior of the combined municipalities' population. Therefore, the combined

POPULATION AND FLOW PROJECTIONS

adjusting factor was applied to the DWWTP service area to project the population change. The 2010 DWWTP service area population was obtained from the DWWTP assessment fact sheet of the 2010 PRASA Water and Wastewater Infrastructure Master Plan (the PRASA Master Plan). Table 2-2 shows the estimated and projected population for the DWWTP service area.

Table 2-2: DWWTP Service Area Population Estimates and Projections

	Year								Adjusting Factor
	2010	2012	2015	2020	2025	2030	2035	2038	
DWWTP Service Area Population	20,987	21,189	21,492	21,866	22,119	22,251	22,262	22,211	96%
Adjusted DWWTP Service Area Population	20,108	20,302	20,592	20,950	21,193	21,319	21,330	21,281	

2.2 Flow Estimates

The flow data for the DWWTP was obtained from the Discharge Monitoring Reports corresponding to the 2012. The monthly average and daily maximum flow data was used to calculate the annual average and maximum flow. Figure 2-1 shows the monthly average flow registered at the plant. An annual average was calculated in 2.29 MGD.

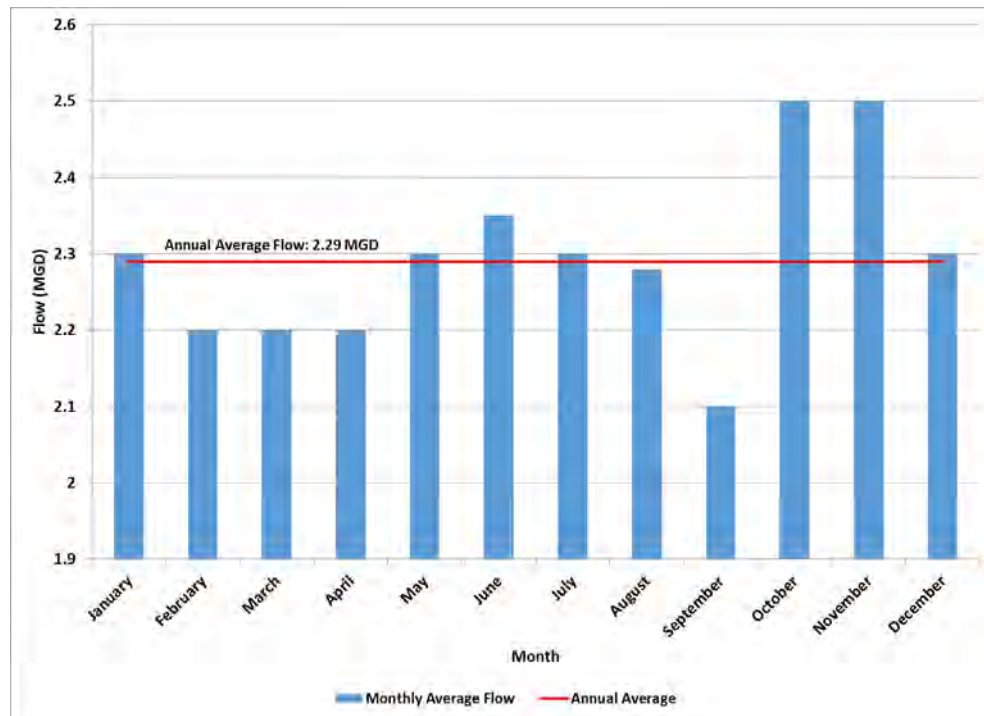


Figure 2-1: 2012 Flow Data for the DWWTP

POPULATION AND FLOW PROJECTIONS

The monthly maximum flow is shown in Figure 2-2. The maximum flow for year 2012 was 3.80 MGD.

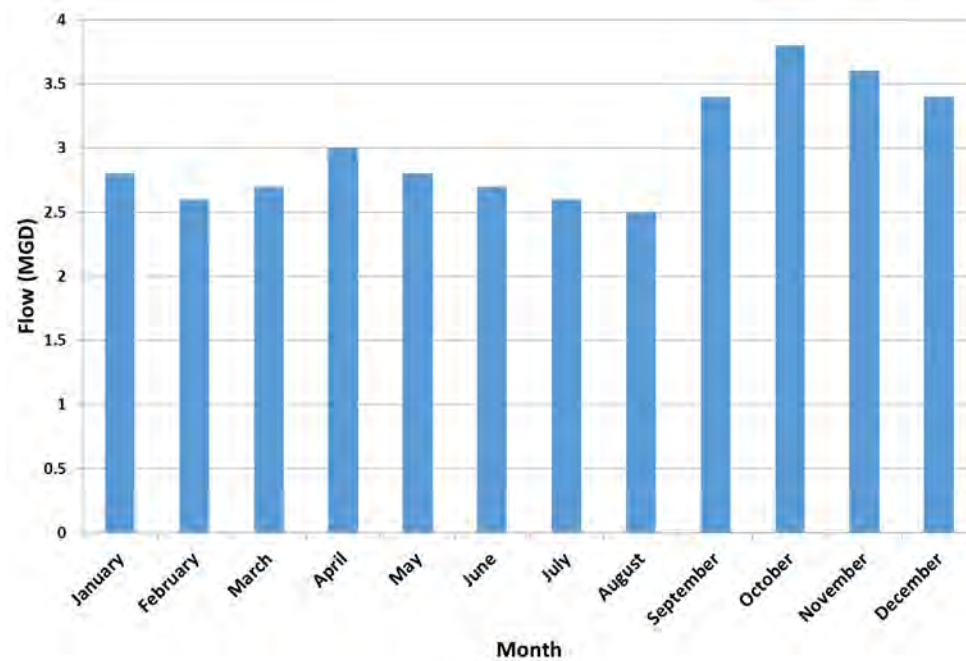


Figure 2-2: 2012 Monthly Maximum Flow for DWWTP

The annual average flow and the maximum flow were used to estimate the maximum flow ratio; a ratio of 1.66 was obtained. The annual average was used to estimate the per capita wastewater generation rate for the DWWTP service area. Using the 2012 DWWTP adjusted service area population it is obtain a contribution of 112.8 gallons per day (gpd). Using the estimated wastewater flow per capita contribution the wastewater flow was projected from 2015 to 2038. Figure 2-3 shows the wastewater flow projections for the DWWTP service area. It can be observed in the figure that the annual average flow will increase to 2.41 MGD by year 2035, when achieves the highest value. The DWWTP have an average design capacity of 4.05 MGD, therefore, it can be concluded that the DWWTP will have a remaining capacity of 1.64 MGD by year 2038.

As part of this report, in addition to propose an alternative to decrease the overloading of the existing Dorado trunk sewer, it is presented possible lateral sewers to eliminate existing pump stations and proposed future sewer laterals to connect existing communities that currently don't have sanitary sewer system limiting these connections to the remaining plant's capacity.

POPULATION AND FLOW PROJECTIONS

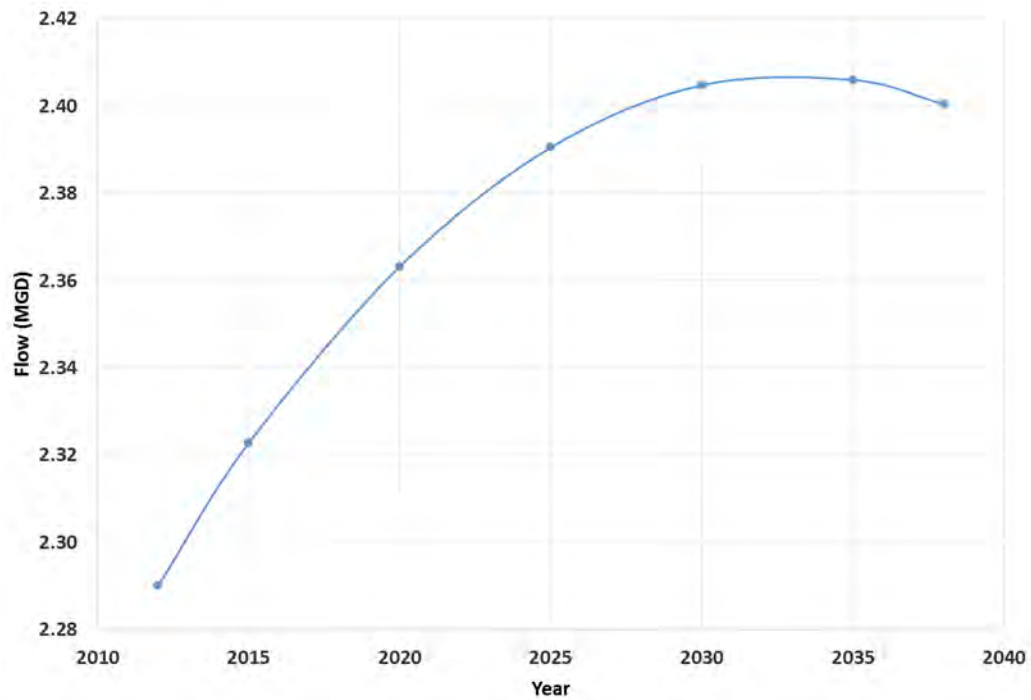


Figure 2-3: Wastewater Flow Projections

3.1 Potential Service Areas

The main objective of this technical report is to alleviate the existing Dorado trunk sewer overloading. However, existing areas without sanitary sewer system were evaluated to determine if the DWWTP can receive the projected wastewater generation of these communities. Also, the wastewater generation analysis was used to plan enough capacity to the corresponding collection pipeline segments. Figure 3-1 shows the potential service area included in the PRASA Master Plan and one additional area located in the North West coast of Dorado, which is next to the Sabana area.

Figure 3-1 shows a total of nine potential areas among the Dorado and Vega Alta municipalities. Table 3-1 presents the existing population and projections for the potential service areas. It was assumed that these areas will follow the same behavior projected for the current DWWTP service area.

Table 3-1: Potential Areas Population Projection

Potential Areas	Year							
	2010	2012	2015	2020	2025	2030	2035	2038
P01	840	848	869	905	954	1,011	1,073	1,135
P02	4,300	4,341	4,404	4,480	4,532	4,559	4,561	4,551
P03	327	330	335	341	345	347	347	346
P04	1,190	1,201	1,219	1,240	1,254	1,262	1,262	1,259
P05	4,299	4,340	4,402	4,479	4,531	4,558	4,560	4,550
P06	2,285	2,310	2,341	2,382	2,407	2,416	2,409	2,398
P07	1,090	1,101	1,116	1,136	1,149	1,156	1,156	1,154
P08	473	478	484	493	499	501	502	501
P09	520	525	533	542	548	551	552	550
Total Population	15,324	15,475	15,702	15,997	16,218	16,361	16,422	16,443

An estimate of the wastewater generation for the existing DWWTP service area and the potential service areas is presented in Table 3-2. The Dorado WWTP will not have the necessary treatment capacity to manage all the potential areas, consequently, not all the identified potential areas can be connected to the DWWTP.

Table 3-2: Wastewater Flow Generation Projections

Population	Year						
	2012	2015	2020	2025	2030	2035	2038
Existing DWWTP Service Area	20,302	20,592	20,950	21,193	21,319	21,330	21,281
All Potential Areas	15,475	15,702	15,997	16,218	16,361	16,422	16,443
Total Population	35,776	36,294	36,947	37,411	37,680	37,752	37,724
Average Wastewater Flow (MGD)	4.04	4.09	4.17	4.22	4.25	4.26	4.26
Maximum Wastewater Flow (MGD)	6.70	6.79	6.92	7.00	7.05	7.07	7.06

In order to discriminate which potential areas can be connected to DWWTP, additional considerations to determine if it is cost effective adding these potential service areas to the DWWTP are needed. As explained previously, this technical report has the objective of identifying which communities can be connected to the DWWTP and to eliminate existing pump stations to decrease operation and maintenance cost. Taking this into consideration, one of the potential areas needs further evaluation to determine if the P05 area can be physically connected to the DWWTP due to the topography and more proximity to other wastewater treatment facilities.

All the remaining potential areas could be connected to the Dorado WWTP. Considering this a revision of the wastewater flow projections is presented in Table 3-3. With the proposed potential areas the projected average and maximum flow will be 3.74 MGD and 6.21 MGD, respectively.

Table 3-3: Wastewater Flow Generation for Proposed Potential Areas

Population	Year						
	2012	2015	2020	2025	2030	2035	2038
Existing DWWTP Service Area	20,302	20,592	20,950	21,193	21,319	21,330	21,281
Proposed Potential Areas	11,025	11,134	11,300	11,518	11,687	11,803	11,862
Total Population	31,327	31,726	32,250	32,711	33,006	33,133	33,142
Average Wastewater Flow (MGD)	3.55	3.60	3.66	3.71	3.74	3.74	3.74
Maximum Wastewater Flow (MGD)	5.88	5.97	6.08	6.15	6.20	6.21	6.21

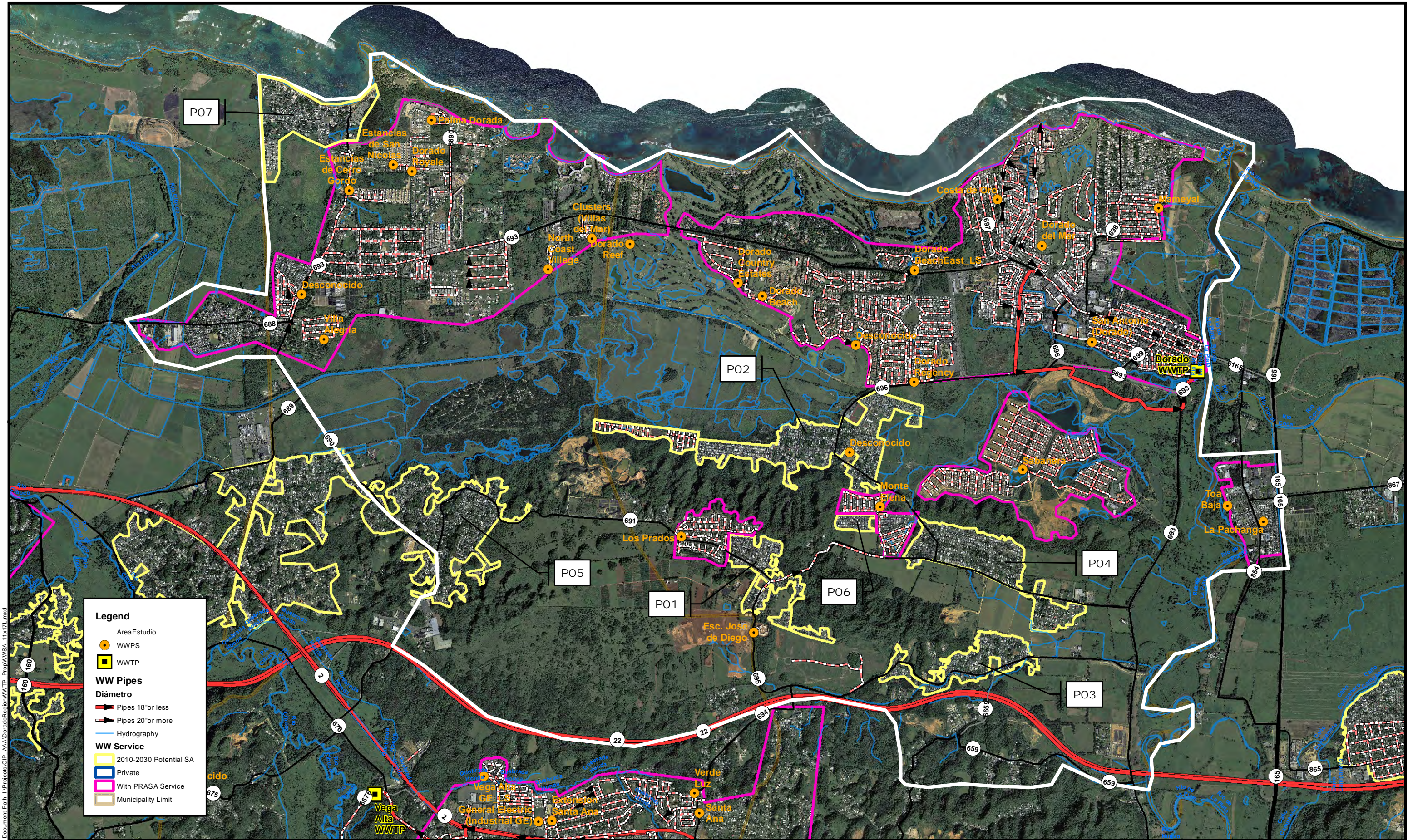


Figure 3-1 - Potential Service Areas in the Study Area

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3.2 Proposed Project

As mentioned in previous sections, this technical report addressed three different objectives:

1. Alleviate the overloading of the existing Dorado trunk sewer.
2. Identify opportunities for elimination of existing sanitary pump stations by gravity lateral sewers to reduce operation and maintenance costs.
3. Proposed possible new connection infrastructure for communities without sanitary sewer system.

However, the principal objective is to present an alternative to avoid the overloading of the existing trunk sewer. Therefore, the proposed alternative will be divided in three stages: Phase A is the recommended phase of the improvements that will address Objective 1. Phase B and C will address Objectives 2 and 3 respectively.

3.2.1 Phase A

The proposed Phase A will address the overloading of the existing Dorado trunk sewer. Figure 3-2 shows the proposed infrastructure in Phase A. This phase proposes a new trunk sewer starting at the intersection of the PR-696 with the José Efrón Avenue until reaching a proposed sanitary pump station that will replace the existing plant pump station and headworks. Also, several lateral sewers are proposed in this phase.

The objective of the proposed infrastructure is to decrease the loading that is currently discharged into a manhole located at the entrance of Quintas del Dorado community and the overloading that is currently occurring along the existing trunk sewer. The proposed Efrón Avenue lateral sewer will allow diverting part of the flow that is currently discharged to the mentioned manhole, which will result in avoiding the overflows of manholes within the community.

3.2.1.1 New Sanitary Pump Station

A new sanitary pump station is proposed to replace the existing pump station and headworks at the DWWTP. This new pump station is proposed next to the Dorado WWTP. The proposed pump station will have a capacity of 4.05 MGD, and will have the area for receiving the tank trucks. The facility will be designed taking into consideration provisions for odor control.

3.2.1.2 Main trunk Sewer and Lateral Sewer

The proposed main trunk sewer will have segments of different pipe diameters. The estimated pipe capacity considers the projected flow for all three proposed phases. The first segment will be of a maximum diameter of 30 inch and a length of 544 meters. This segment starts at the intersection of the José Efrón Avenue with the PR-699 and ends at the turning point in this road of the existing Quintas the Dorado trunk sewer.

From the Quintas de Dorado connection point the new trunk sewer will continue 946 meters (part out of existing roads) until reaching other connection point with a new lateral proposed. This new lateral sewer pipe will have a diameter of 12 inches and a length of 1,422 meters. This pipe will start at the Dorado Beach East SPS. This improvement will require changing the connection pump station's point from the existing point in Quintas del Dorado to the new lateral sewer at the intersection of the José Efrón Avenue and the PR-699.

From its start point the first segment of the main trunk sewer will continue until reaching the PR-693. In which a connection point is proposed to collect the existing flow from Mameyal Area. This pipe segment will have a maximum 30 inch diameter and a length of 889 meters.

The Mameyal area will be connected to a new pipe segment of a maximum diameter 36 inch and a length of 415 meters. This pipe segment starts in the Mameyal Area in PR-693 and ends at the proposed main trunk sewer connection point. From this point, the proposed trunk sewer will continue until reaching the proposed 4.05 MGD.



3.2.1.3 Phase A Cost Estimate

Table 3-4 summarizes the capital costs associated with this phase. The opinion of probable cost is considered a Class 5 estimate with an expected accuracy of -30% to +50%. Phase A has a construction cost of approximately \$7.3 M and an investment cost of approximately \$11.5 M. The investment cost considers design, inspection, and services during construction, contingencies and general administrative cost.

Table 3-4: Phase A Cost Estimate

	Item	Quantity	Unit	Unit Cost	TM Cost
1	New Pump Station (4.05 MGD)	1	LS	\$1,200,000.00	\$1,200,000
2	Main Trunk Sewer				
	36" pipe	415	EA	\$610.00	\$254,000
	30" pipe	2,369	EA	\$530.00	\$1,256,000
3	Lateral Sewers				
	12" pipe	1,422	LM	\$150.00	\$214,000
4	Trench Excavation for 36", 30"				
	3.01 - 4.00 M	2,138	EA	\$300.00	\$642,000
	4.01 - 5.00 M	900	EA	\$520.00	\$468,000
	5.01 - 6.00 M	300	EA	\$650.00	\$195,000
5	Trench Excavation for 12"				
	0.01 - 2.00 M	1,297	EA	\$65.00	\$85,000
	2.01 - 3.00 M	75	EA	\$100.00	\$8,000
	3.01 - 4.00 M	50	EA	\$200.00	\$10,000
6	Manholes (1.20 meters diameter)				
	0.01 - 3.00 M	15	EA	\$3,000.00	\$45,000
	2.01 - 3.00 M	3	EA	\$3,500.00	\$11,000
	3.01 - 4.00 M	4	EA	\$4,500.00	\$18,000
7	Manholes (1.80 meters diameter)				
	2.01 - 3.00 M	15	EA	\$5,700.00	\$86,000
	3.01 - 4.00 M	10	EA	\$7,500.00	\$75,000
	4.01 - 5.00 M	8	EA	\$9,500.00	\$76,000
	5.01 - 6.00 M	3	EA	\$12,000.00	\$36,000
8	Demolition, replacement of asphalt, traffic control devices, additional excavation for bedding materials and others	1	LS	\$800,000.00	\$800,000
Construction Cost Sub-Total					\$5,479,000
6	Sitework & Yard Piping (5%)				\$273,950
7	Electrical Work (8%)				\$438,320
Construction Cost Sub-Total					\$6,191,270
Overhead & Profit (18%)					\$1,114,500
Total Construction Cost					\$7,305,770
Total Investment Cost					\$11,485,000

3.2.2 Phase B

The proposed Phase B will address the objective of eliminating existing pump stations to decrease operation and maintenance costs. Figure 3-3 shows the infrastructure proposed under this phase. It is important note, that in order to construct Phase B, the proposed Phase A needs to be fully operational.

Phase B consists in the extension of the proposed trunk sewer in Phase A and several lateral sewers that will eliminate existing pump stations allowing the connection of the communities being served by gravity, instead of force line.

3.2.2.1 Phase B Main Trunk Sewer

The proposed Phase B trunk sewer will start at the PR-696 at the western limit of the Dorado Country Estates community. This proposed trunk sewer segment will have pipe sections with different diameters; the first section will have a maximum diameter of 18 inches and a length of 1,200 meters. The second pipeline section will have a maximum diameter of 24 inches and a length of 852 meters. The proposed trunk sewer ends at the intersection between the José Efrón Avenue and the PR-696, which is the starting point of the main trunk sewer segment proposed in Phase A.

3.2.2.2 Phase B Lateral Sewers

In Phase B, several lateral sewers are proposed to eliminate existing sanitary pump stations. The first proposed lateral sewer will start at the existing San Antonio SPS and will connect with the proposed main trunk sewer in Phase A. This new lateral sewer will have a maximum diameter of 12 inch and a length of 832 meters. This lateral sewer will allow the elimination of the existing San Antonio SPS and will manage part of the generated wastewater flow from the Dorado Urban area.

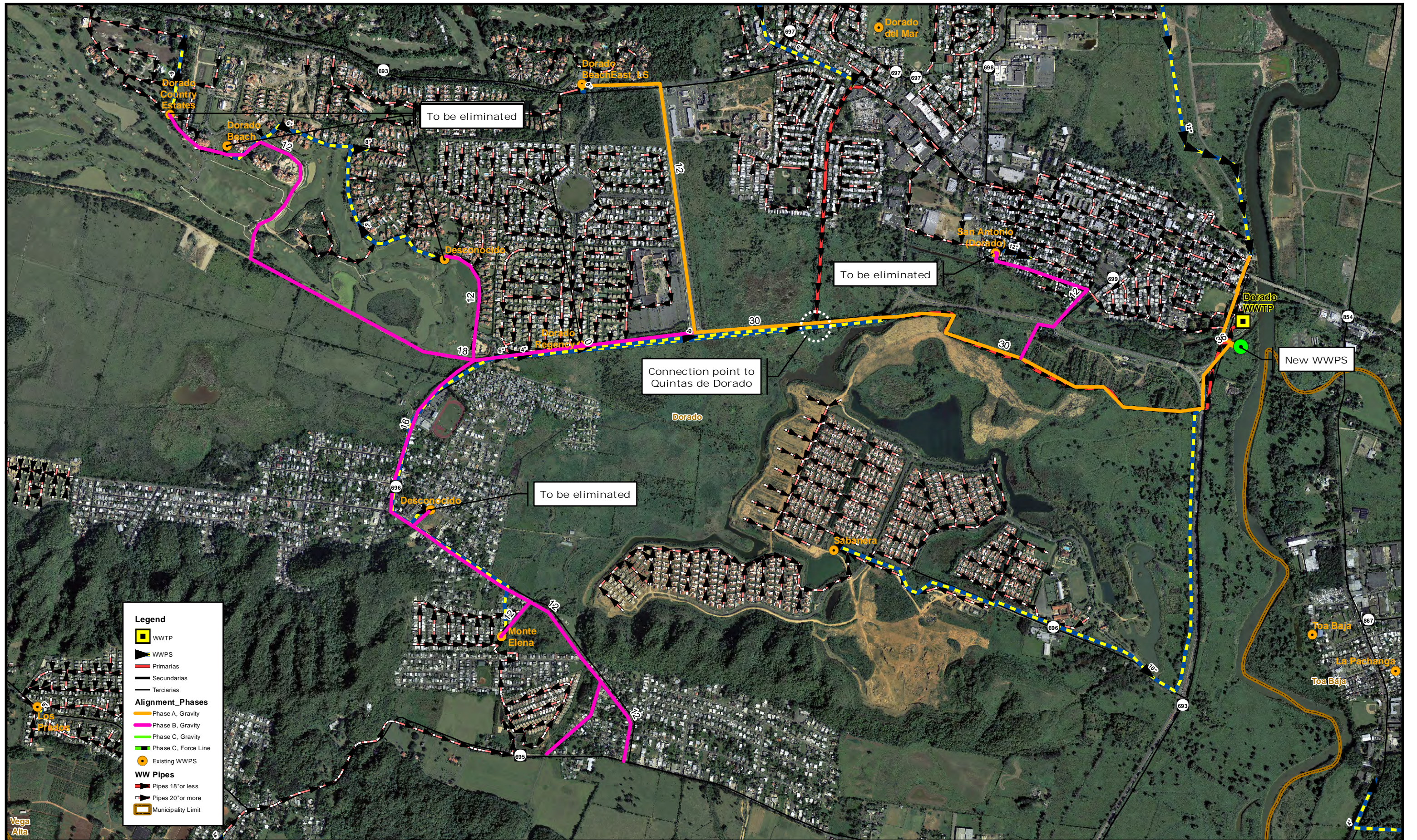
The second lateral sewer will start at the existing Dorado Country Estates Pump Station and will continue until reaching the starting point of the proposed Phase B main trunk sewer. This lateral sewer will have a maximum diameter of 12 inches and a length of 955 meters. This lateral sewer will also collect the flow from the existing Dorado Beach Pumps Station. This lateral sewer will convey the flow generated at the Dorado Country Estates community.

A third lateral sewer will start at the existing pump station located in the Paseo Las Olas community. This lateral will have a maximum diameter of 12 inches and a length of 603 meters, and will end at the intersection between the PR-696 and the entrance to the Dorado Beach Resort. In this area the connection of the Dorado Regency Sanitary Pump Station is proposed. This will allow the elimination of the pump station and will convey by gravity the flow generated

in the Paseo Dorado, Paseo del Mar, Paseo Real, Paseo del Sol and Paseo los Corales communities.

A fourth lateral sewer is proposed in this phase, it starts at the existing Monte Elena Pump Station, and will allow the elimination of this pump station. The proposed pipeline will have two segments of different pipe diameters. The first one will have a maximum diameter of 12 inches and a length of 817 meters. This first segment will manage the flow generated at the Monte Elena, Arenal, Arenal 2 and San Antonio communities. It will also allow eliminating other sanitary pump station located in the San Antonio community.

The other segment of the fourth lateral sewer will have a maximum diameter of 15 inches and a length of 890 meters. This pipeline segment will collect the flow generated in part of the San Antonio community. This lateral sewer will also ends at the intersection between the PR-696 and the entrance of the Dorado Beach Club.



3.2.2.3 Phase B Cost Estimate

Table 3-5 summarizes the capital costs associated with this phase. The opinion of probable cost is considered a Class 5 estimate with an expected accuracy of -30% to +50%. Phase A has a construction cost of approximately \$4.14 M and an investment cost of approximately \$6.5 M. The investment cost considers design, inspection, and services during construction, contingencies and general administrative cost.

Table 3-5: Phase B Cost Estimate

	Item	Quantity	Unit	Unit Cost	TM Cost
1	Main Trunk Sewer				
	24" pipe	852	EA	\$485.00	\$414,000
	18" pipe	1,200	EA	\$369.00	\$443,000
2	Lateral Sewers				
	15" pipe	890	EA	\$273.00	
	12" pipe	3,212	EA	\$150.00	\$482,000
3	Trench Excavation for 24", 18"				
	2.01 - 3.00 M	452	EA	\$150.00	\$67,800
	3.01 - 4.00 M	1,600	EA	\$300.00	\$480,000
4	Trench Excavation for 15", 12"				
	0.01 - 2.00 M	1,980	EA	\$65.00	\$129,000
	2.01 - 3.00 M	1,450	EA	\$100.00	\$145,000
	3.01 - 4.00 M	672	EA	\$200.00	\$135,000
5	Manholes (1.20 meters diameter)				
	0.01 - 3.00 M	27	EA	\$3,000.00	\$81,000
	2.01 - 3.00 M	13	EA	\$3,500.00	\$46,000
	3.01 - 4.00 M	12	EA	\$4,500.00	\$54,000
6	Manholes (1.80 meters diameter)				
	2.01 - 3.00 M	6	EA	\$5,700.00	\$35,000
7	Demolition, replacement of asphalt, traffic control devices, additional excavation for bedding materials and others	1	LS	\$1,000,000.00	\$1,000,000
Construction Cost Sub-Total					\$3,511,800
Overhead & Profit (18%)					\$632,200
Total Construction Cost					\$4,144,000
Total Investment Cost					\$6,515,000

3.2.3 Phase C

Phase C will address the objective of providing the conveyance pipelines for the connection of existing communities that don't have sanitary system. The purpose is to provide collectors to connect the potential service areas identified in Section 3.1, preferably by gravity. Figure 3-4 shows the proposed infrastructure under this phase. To be able to implement this phase, phase A and B must be fully operational.

Phase C consists in several lateral sewers to be connected to the main trunk sewer proposed in phases A and B. extension of the proposed trunk sewer in Phase A. The proposed Phase C infrastructure will add an additional 1.34 MGD to the flow projected for 2038 of the existing DWWTP service area.

3.2.3.1 Main Lateral Sewer

A main lateral sewer (or sub-trunk sewer) is proposed along part of the PR-693, this pipeline will have segments of different diameters. The pipe starts at 12 inches and change to 15 inches until the connection point with the proposed main trunk sewer in Phase A. This pipe will have a total length of 3,337 meters.

3.2.3.2 Lateral sewers to Connect Potential Service Areas

Potential Service Area 1

The potential area 1 corresponds to part of the Jardin Dorado community. It is proposed to connect this community through an existing pipe. This existing pipe will be connected to the lateral sewer proposed in Phase B which that starts at the existing Monte Elena pump station.

Potential Service Area 2

Other lateral sewer proposed is to provide sanitary service to the Arenal 2 and part of Arenal communities. This proposed lateral will follow a cross country route until reaching the connection point at the entrance of the Dorado Beach Resort. This pipe will have a maximum diameter of 12 inches and a length of 1,200 meters.

Potential Service Area 3

This lateral sewer will allow connecting part of the Higuillar Ward. This connection will be through a 12 inches gravity pipe and a length of 3,090 meters. The lateral start at the Higuillar ward at the PR-694 and ends at the proposed main trunk sewer in PR-693.

Potential Service Area 4

The potential area 4 considers the Doraville urbanization. This community will be connected by gravity through a pipe of 12 inches and a length of 2,050 meters. This lateral start at PR-695 in the Doraville urbanization and end at the proposed main trunk sewer in PR-693.

Potential Service Area 5

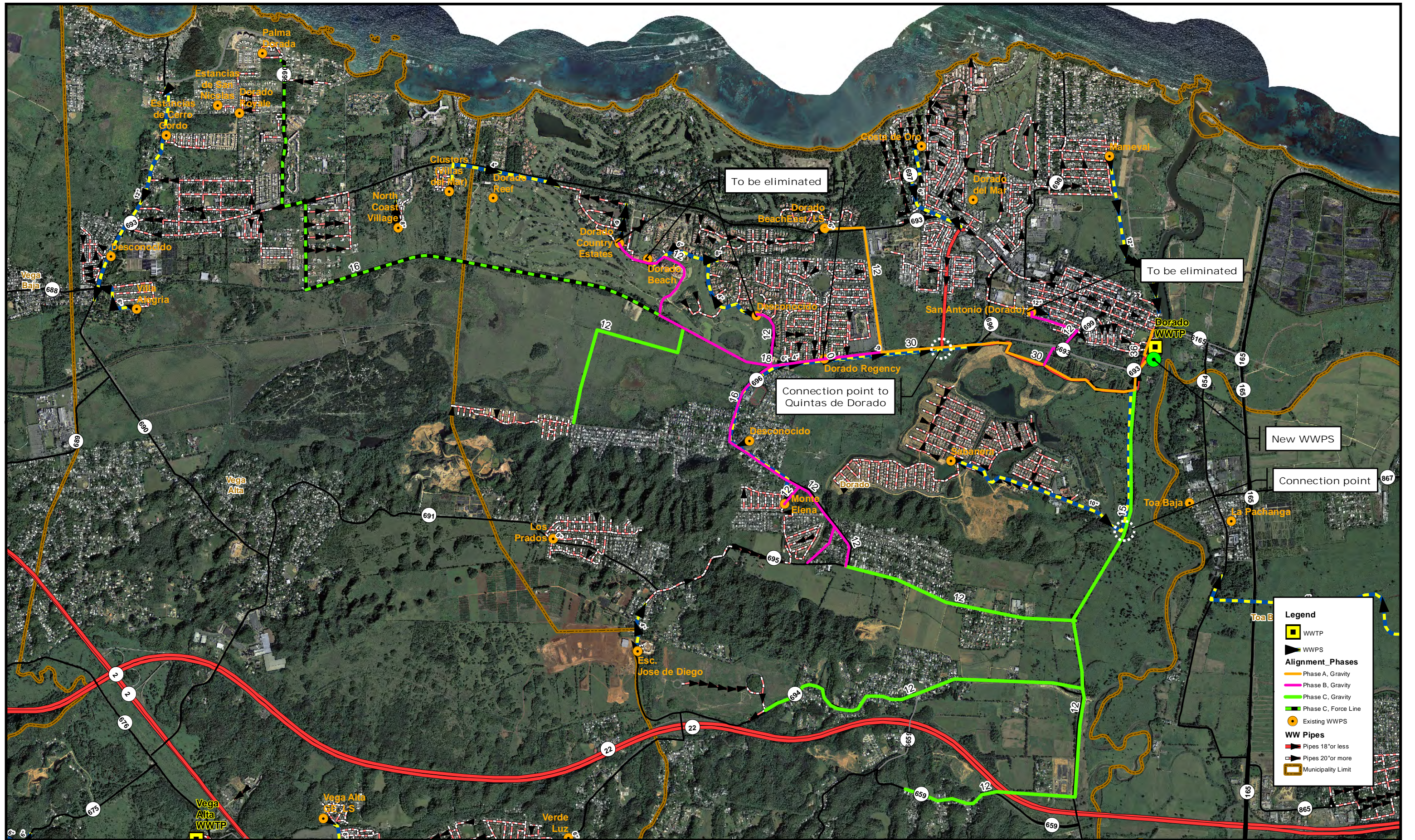
It was determine that the potential service area 5 will be evaluated separately to determine to which treatment facility can be connected. As explained in Section 3, this area is closer to other treatment facilities, and due to its topography can be difficult to connect it to the DWWTP.

Potential Service Area 6

The lateral sewer starts at the Sabana community and ends in the starting point of the main trunk sewer proposed in phase B. This pipe will be a force line of 16 inches diameter. A new pump station is proposed to be located in Sabana community; this pump station will have a capacity of approximately 100 gpm. This connection will allow providing sanitary system to the north western part of Sabana Community.

Potential Service Area 7

The lateral sewer proposed to connect potential service area 7 will start PR-659 at the Espinoza Ward and ends at the starting point of the proposed main trunk sewer at the PR-693. This pipe will have a diameter of 12 inches and a length of 2,030 meters.



3.2.3.3 Phase C Cost Estimate

Table 3-6 summarizes the capital costs associated with this phase. The opinion of probable cost is considered a Class 5 estimate with an expected accuracy of -30% to +50%. Phase A has a construction cost of approximately \$8.1 M and an investment cost of approximately \$12.8 M. The investment cost considers design, inspection, and services during construction, contingencies and general administrative cost.

Table 3-6: Phase C Cost Estimate

	Item	Quantity	Unit	Unit Cost	TM Cost
1	Main Trunk Sewer				
	15" pipe	1,181	EA	\$273.00	\$323,000
	12" pipe	2,156	EA	\$150.00	\$324,000
2	Potential Area 2 Connection				
	12" pipe	1,200	EA	\$150.00	\$180,000
3	Potential Area 3 Connection				
	12" pipe	3,090	EA	\$150.00	\$464,000
4	Potential Area 4 Connection				
	12" pipe	2,050	EA	\$150.00	\$308,000
5	Potential Area 6 Connection				
	16" force line	7,145	EA	\$520.00	\$3,716,000
	New PS	1	LS	\$400,000.00	\$400,000
6	Manholes				
	0.01 - 3.00 M	21	EA	\$3,000.00	\$63,000
	2.01 - 3.00 M	16	EA	\$3,500.00	\$56,000
	3.01 - 4.00 M	11	EA	\$4,500.00	\$50,000
7	Demolition, replacement of asphalt, traffic control devices, additional excavation for bedding materials and others	1	LS	\$1,000,000.00	\$1,000,000
Construction Cost Sub-Total					\$6,884,000
Overhead & Profit (18%)					\$1,239,200
Total Construction Cost					\$8,123,200
Total Investment Cost					\$12,770,000

4.1 Conclusions and Recommendations

This technical report addressed three main objectives:

1. Alleviate the overloading of the existing Dorado trunk sewer.
2. Identify opportunities for elimination of existing sanitary pump stations by gravity lateral sewers to reduce operation and maintenance costs.
3. Proposed possible new connection infrastructure for communities without sanitary sewer system.

However, the main objective is to address Objective 1. Therefore, it is recommended initiating a design process for Phase A. The Phase A provides the solution for the Quintas del Dorado overflow of manholes and also takes into consideration the necessary capacity to eventually construct phases B and C to gravity provide conveyance for the area of study. Also, it is recommended further evaluation to determine the best way of connecting the existing communities without sanitary sewer system.

The proposed Phase A has an estimated construction cost of \$7.3M and an estimated investment of approximately \$11.5M.

5.1 Phase A Project Schedule

A summary of the schedule milestones is shown below:

Table 5-1: Project Schedule Summary

Activity	Schedule (due date)
Technical Memorandum	September 2013 - Completed
Complete Design Procurement	November 2013
Complete Design	March 2014
Complete Bid Procurement	September 2014
Complete Construction	May 2015

Based on this schedule it is expected that the project will be completed by May 2015.

6.1 Permits Plan

A Preliminary Permits Plan is provided in **Table 6-1** below:

Table 6-1: Preliminary Permits Plan

Environmental Permits and Endorsements	Responsible Party	Scheduled
OGPe Environmental Compliance	MPPR	BBS
DTPW Endorsement	Designer	BBS
Dorado Municipality Endorsement	MPPR	BBS
OGPe Tree Removal, Trimming and Replanting Permit	MPPR	BBS
Local Hydraulic and Hydrology Study	Sub-consultant	BBS

BBS – Before Bid Start

6.2 Land Acquisition

Land acquisition will be necessary for the cross country portion of the pipeline and the proposed pumping station. Nevertheless, this opinion will be verified during the design stage and the pre-construction management modified accordingly.

7.1 References

- PRASA Water and Wastewater Infrastructure Master Plan, April 2011, MPPR/Malcom Pirnie
- Planning Report. Dorado Region Sanitary Sewer System, March 2013, CH Caribe/CH2M Hill.
- Rules and Regulations for the Design Standards, December 1983, PRASA